Views of the Science Community on Communicating to the Public about Nanoscale Science, Engineering and Technology

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Background

A new national Nanoscale Informal Science Education Network (NISE Net) was launched in the Fall of 2005 with funding from the National Science Foundation with the mission of fostering public awareness, engagement, and understanding of nanoscale science, engineering, and technology through the establishment of a national infrastructure that links science museums and other informal science education organizations with nanoscale science and engineering research organizations.[1]

This survey was conducted as one part of a set of four front-end evaluation activities to help guide in the planning of public exhibitions, programs, media, and web content for NISE Net. A primary goal was to solicit and capture thoughts and opinions about which ideas about nanoscale science, and engineering and developing nanotechnologies are important to communicate to the public from the many stakeholders working in these areas. A second goal was to ensure NISE Net was aware of recent developments and work done in the area of nanoscience education that might not have been met by literature reviews alone.

The Study

In September 2005, seventy people were identified and recruited to participate in the study (Males: 48; Females: 24)

. Participants had to meet at least two of the following criteria to receive a survey:

- Acknowledged expertise in researching, implementing, communicating, or using the processes and practices of nano sciences, engineering, and technologies.
- Accomplished a significant prior work either in research, creative works, public outreach, leadership, media, or communications in nanoscale science, engineering, and technology

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The Museum of Science in Boston is leading this five-year effort in partnership with the Exploratorium in San Francisco and the Science Museum of Minnesota in St. Paul, with the collaboration of more than a dozen other science research and education institutions.

- Belongs to an existing funded project or center conducting work in nanoscale research, nano technology, and/or education (i.e., MRSEC, NSEC, NNIN, NNI, N-IMD, N-ISE, NCLT)
- Recognized by NISE Net leadership as a potential important contributor

The final list was reviewed as a whole to ensure there was adequate representation from a range of science and engineering disciplines. Table 1 shows the categories of survey participants.

Table 1: Participants who received a survey and responded to it.

CATEGORY OF PARTICIPANT	# who Received survey	# who Responded to survey	% Returned survey
Scientists, Professors of Sciences & Engineering, Industry research scientists and engineers:	42	10	24%
Social scientists, historians, philosophers, and sociologists of science	10	2	20%
Science educators, education professors, science outreach leaders	10	5	50%
Artists, illustrators	5	2	40%
Public media, Communications	3	1	33%
TOTAL NUMBER OF PARTICIPANTS	**70**	**20**	**28.5%**

Method & Survey Questions

Participants were asked four key questions using an open-ended response survey sent via email.

Question 1: What do you believe are the three most essential ideas to communicate to the public about nanoscale science, engineering and technology, and why?

Question 2: What prior efforts at public communication of nanoscale science, engineering, and technology have you witnessed, and how do you think they have achieved or failed?

Question 3: Who do you consider one or some of the best public communicators on nanoscale science and engineering and its societal implications?

Question 4: What do you believe is the most important challenges that the NISE Net needs to address in order to achieve its development and delivery goals and to have a lasting educational impact?

Participants could write as much or as little as they wanted, as well as provide additional comments at the end of the survey. Surveys were returned by email as well as by airmail and fax.

Findings

Twenty of the seventy participants returned completed surveys (28.5%). Four people (5%) replied to the solicitation, but declined to participate for various reasons that included not having enough time and/or replying they did not believe they should participate either because another person in their organization could better fill out the information or their participation was not appropriate to the study. The low return rate was also attributed to the timing of the survey and the lack of any incentive to complete the survey. (We expect that many professors were beginning fall courses at the start of a semester when the survey was distributed and had a limited time of 4 weeks to respond to the survey. In addition, no gift or cash incentives were provided to complete the survey.)

Question 1: Ideas to Communicate

An analysis of the responses of the first question [*What do you believe are the three most essential ideas to communicate to the public about nanoscale science, engineering and technology, and why?*] were categorized into multiple themes, then grouped into three main categories of responses: 1) science, engineering, and scientific aspects, 2) the impact of nanoscience research on science and technology, and 3) public perceptions.

Table 1: Responses to Question 1

Response category	**Percent**	**Number**
Scientific aspects – What is nano?	**%**	**26**
Physical laws / phenomena / interactions operate differently	50%	9
New engineering processes / building nanomaterials	44%	8
Nano means small size / give sense of scale	39%	7
Big questions / challenges in nanoscale science/nanotech	11%	2
Impact of Nano on science and technology	**%**	**16**
There are many applications (e.g., technology, health, etc)	61%	11
Nano is not really different / new science	17%	3
Nano will affect other sciences	11%	2
Public Perceptions	**%**	**12**
Dispel fictions / mollify fears	28%	6
Importance of funding / competing with other countries	22%	4

Make explicit the risks of nano	17%	3
Potential for careers in science	6%	1

* see Appendix for charted data

In terms of communicating the science aspects of nanotechnology, respondents felt it would be important for NISE Net to communicate that the physical laws, properties, and interactions at the nanoscale behavior differently at that scale.

> *"The science at nanoscale is often different than that at micro or macroscales. The rules of the game change at those scales and phenomena become size dependent. This poses challenges to understand how nature works, and also opportunities to create entirely new ways of using nature for the benefit of society."*

Respondents felt that with respect to informing the public about nanotechnology impact, it would be important to communicate the different materials that can be engineered and the many applications that nanotechnology will have in health, medicine, textiles, transportation, energy, electronics, information technology, and other areas. By grounding nanotechnology in basic real-world applications and everyday examples, it could be used as an approach to building public trust and understanding of nanotechnology.

With respect to public perceptions, the respondents felt that it would be important for NISE Net to dispel any misconceptions or fears that the public may have about nanotechnology, for example that little robots don't self-assemble themselves and attack humans. Note that while this was a concern raised and anticipated by the respondents of the survey who represent the science community's views in this study, Flagg's literature review of public perceptions found that the public had few if any prior conceptions about nanotechnology (see Flagg, www.informallearning.org).

Across all categories of responses to the question of what is essential to communicate to the public, the most common idea mentioned was to show the many different applications of nanotechnology.

> *"It is likely that nanoscale science, engineering, and technology will influence most technological aspects of our lives – health, information, transportation, energy, etc."*

> *"The potential for nano to change health care delivery systems is immense. It isn't to far off in future in which we might be able to develop drugs that can deliver the right dose of medicine to an infective area in the body (say a cancer cell) or perhaps little molecular machines to clean out our arteries."*

> *"The impact nanotechnology is having and will have even more in the future on every aspect of their lives from their healthcare to the clothing they wear."*

Question 2: Prior efforts, success and failures

Question 2 asked, "What prior efforts at public communication of nanoscale science, engineering, and technology have you witnessed, and how do you think they have achieved or failed?" The survey responses provided many examples of prior efforts at teaching the public about NSET. Overall, there were no consistent nor frequently cited examples of prior efforts or formats given, but included a range of examples from local outreach efforts that partnered with universities to public lectures to traveling exhibitions, children's websites, high school programs, and one-day events including different types of public forums. One common theme mentioned the potential failure of not starting where the audience is in terms of their background knowledge and striking a balance that is neither superficial nor too technical.

At the same time, another common opposing theme felt by others was a concern that the not enough emphasis and attention would be placed on science and the learning of the science, but only a focus on awareness of nanotechnology. Another current failure but potential promise of NISE Net would be a central place by which to communicate accurate science to the media to prevent inaccurate or false science reporting currently propagated by the press.

> *"Efforts that fail do not take into account the level of understanding of the audience. Efforts that succeed try to figure out where their audiences are and then build programs and resources that meet those audiences at that place. These efforts build on people's prior understanding and customize programs to ensure that everyone takes something away from the experience."*

> *"Most are able to get people interested but they lack an understanding of how people learn and how they are able (or not) to perceive science at this scale."*

> *"By ignoring the fact that nanoscience is not an entity in itself, most of the efforts that I have seen—both in communicating to the public and in pre-college "motivation and awareness" programs—give short shrift to understanding and replace it with something very superficial that easily leads to either positive hype close to magic or to negative hype close to doomsday scenarios. It is hard to balance the good and the bad of a technology, including nanotechnology, without some level of understanding of what is new and why."*

Question 3: Best Communicators of NSET

When asked, "Who do you consider one or some of the best public communicators on nanoscale science and engineering and its societal implications?" respondents collectively generated a list of thirty-two people. (See Appendix B). The top three names which were mentioned multiple times included the late Richard Smalley, inventor of the Bucky ball, Art Ellis from the University of Wisconsin, and George Whitesides from Harvard University. Others that were mentioned multiple instances include David Soane from Soane Labs, Wendy Crone from University of Wisconsin, Paul Alivisatos from the University of California/Lawrence Berkeley Laboratories, Mark Ratner from Northwestern, and Mihail Rocco from the National Science Foundation.

Question 4: Challenges for NISE Net

The final question on the survey asked, "What do you believe is the most important challenge that the NISE Net needs to address in order to achieve its development and delivery goals and to have a lasting educational impact?" Figure 1 provides a visual representation of the areas that were mentioned by respondents that included challenges at the audience focus and design level, programmatic challenges, and administrative and operational challenges. A strong prevailing theme in the responses were directly related to some aspect of the need to work towards stronger communication and a coordinated partnership, whether that takes place within the NISE Network, or with its Network partners, the public, K12 and informal educators, and the media/press. The following quotes express this sentiment.

> *"There are many partners involved in this effort and this means a great deal of time will need to be set aside to manage the partnership. This will be no mean effort and will take more time than anyone is expecting."*

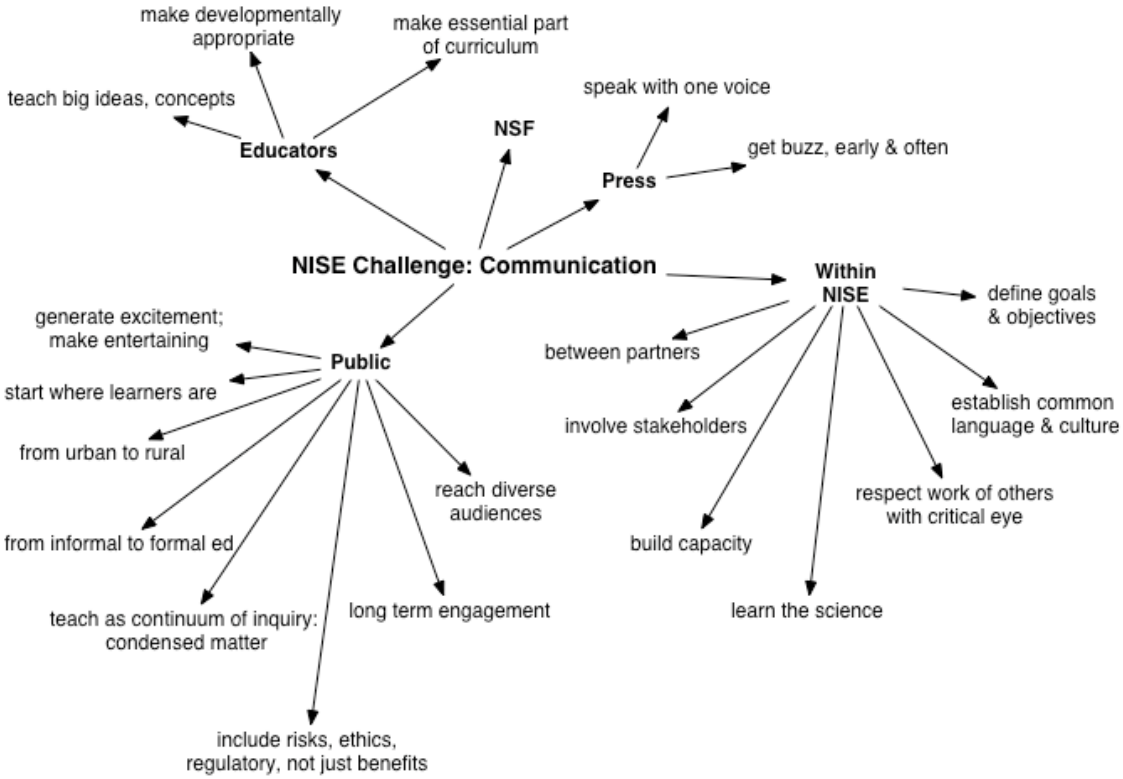
> *"In the end, the Network needs to speak with one voice – again, a major challenge in a multi-faceted partnership. A coordinated national effort that avoids getting bogged down in turf battles and facilitates true sharing amongst all institutions and partners."*

> *"I think there needs to ample communication between the NISE partners. Programs on the scale of NISE tend to fail most often because of lack of communication between the partners, if that can be overcome I think NISE can have great impact on educating the public about nanoscale science and engineering."*

Comments addressed both the need to educate the public about nanoscience, engineering, and technology, including the science and the risks and benefits of nanotechnology, but also comments included strategic advice in terms of building the capacity of the NISE Network such as establishing a common language between scientists and informal educators, involving partners early and often, as well as making sure NISE Net

recognizes and respects the work of others in this area, while maintaining a critical stance towards what works for informal science education.

> *"Establish a language and a culture among the researchers and informal educators. Getting their act together and moving forward in a coordinated fashion that does not fall victim to different camps and the relatively false nature of a network fashioned to work on nano stuff."*



Summary

In summary, there was a wealth of ideas contributed via the survey by the community to the NISE Network that pointed to areas of opportunity, challenges, and potential pitfalls. Overall, there was a sense of enthusiasm and support for the NISE Network's purpose and mission to foster public awareness, engagement, and understanding of nanoscale science, engineering, and technology given that we take advantage of existing prior knowledge, prior initiatives, efforts, and research across disciplines to help build national infrastructure that links science museums and other informal science education organizations with nanoscale science and engineering research organizations.

Acknowledgments

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Appendix A: Question 1 Data

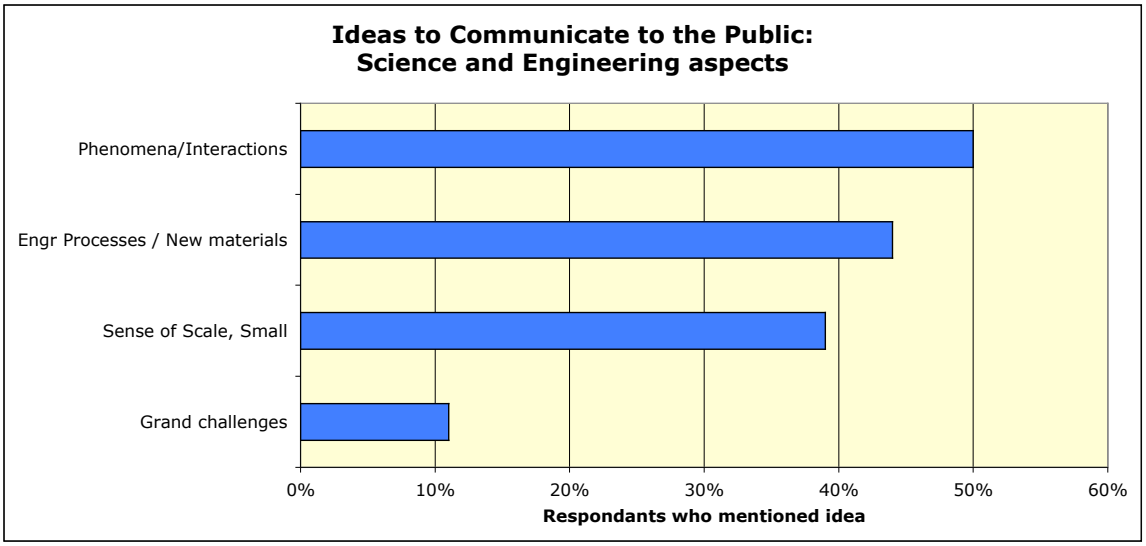

Table A1: Responses from Question 1 for category: science and engineering aspects

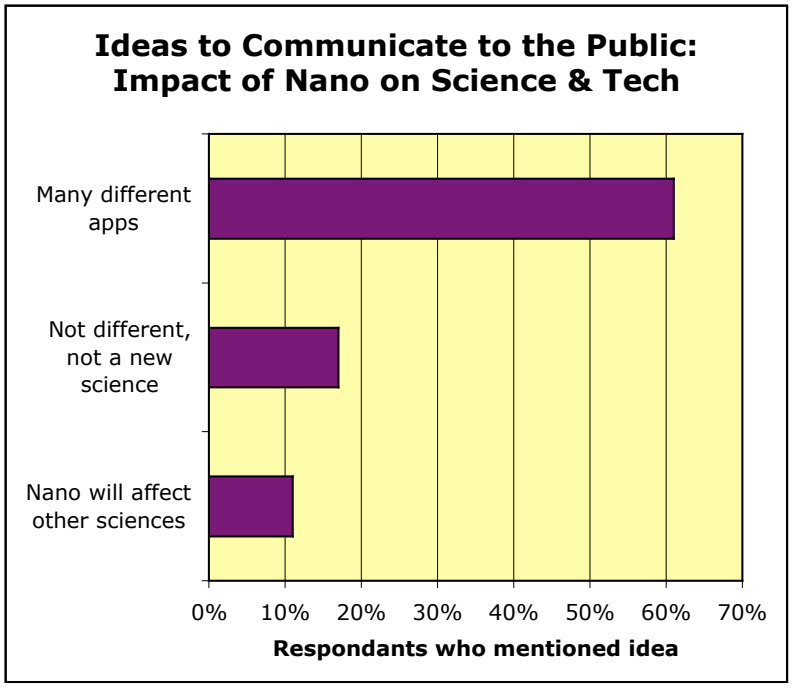

Table A2: Responses from Question 1 for category: Impact of nano on science and technology

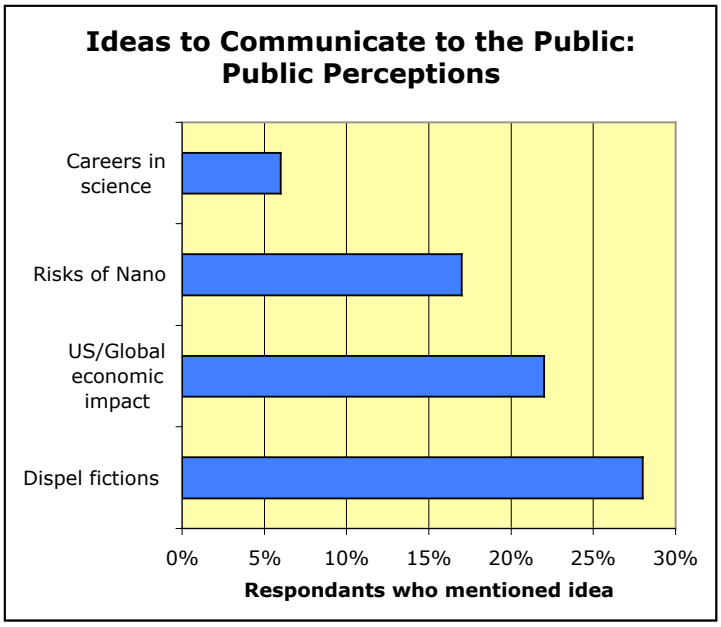

Table A3: Responses from Question 1 for category: Public Perceptions

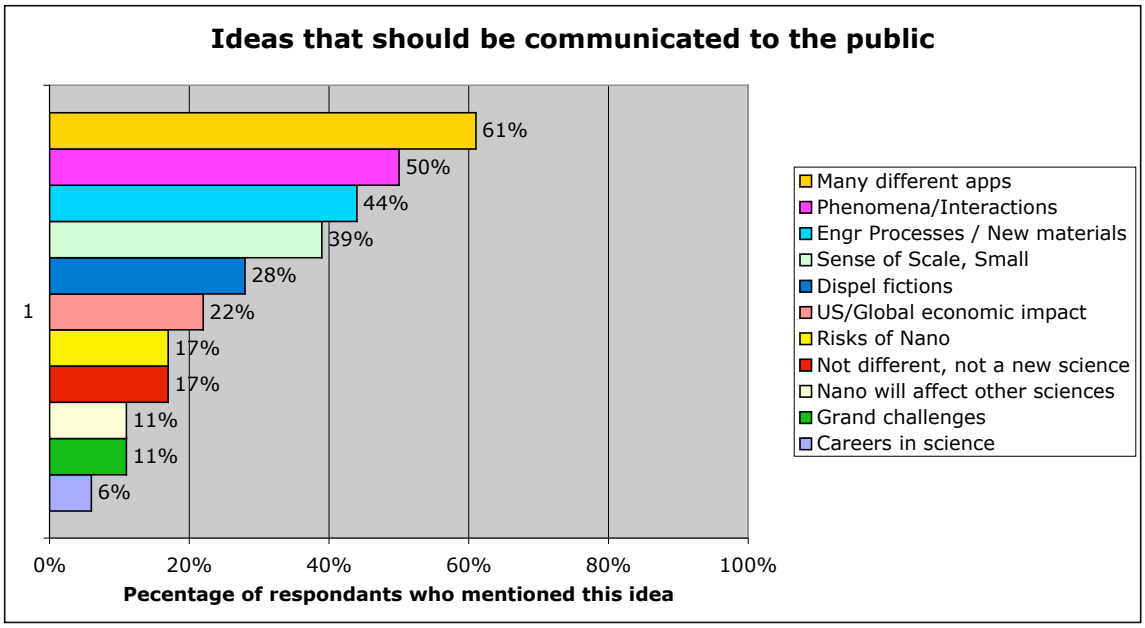

Table A4: Overall combined responses from Question 1

Appendix B: Best public communicators on nanoscale science and engineering and its societal implications

Angelica Stacy, UC Berkeley
Art Ellis, University of Wisconsin
Chris Toumey, University of South Carolina

David Awshalom, UC Santa Barbara
David Soane, Soane Labs
Deb Newberry, Nanotechnology Group, Minneapolis
Don Eigler, IBM Almaden
Eric Drexler, Foresight Institute
Eric Heller, Harvard University
Eric Mazur, Harvard University
Felice Frankel, MIT
Gail Jones, North Carolina State
George Lisensky, Beloit College (associate with U of Wisconsin MRSEC
George Whitesides, Harvard University
Heine Rohrer, IBM Zurich
Horst Stormer, Columbia University
Kristen Kulinowski, CBEN, Rice University
Mara Prentiss, Harvard University
Mark Ratner, Northwestern University
Mark Tuominen, University of Massachusetts: Amherst
Michael Roukes, California Institute of Technology
Mike Falvo, Univ. of North Carolina at Chapel Hill
Mike Rocco, NSF
Mildred Dresselhaus, MIT
Paul Alivisatos, UC Berkeley/LBNL
Richard Smalley, Rice University (deceased)
Steve Fonash, Penn State
Steven Chu, UC Berkeley/LBNL
Tejal Desai, Boston University
Vicki Colvin, Rice University
Wendy Crone, University of Wisconsin